SYM-AM-16-079

PROCEEDINGS
OF THE
THIRTEENTH ANNUAL ACQUISITION RESEARCH SYMPOSIUM

THURSDAY SESSIONS
VOLUME II

Squaring the Project Management Circle: Updating the Cost, Schedule, and Performance Methodology

Charles Pickar, Senior Lecturer, NPS

Published April 30, 2016

Approved for public release; distribution is unlimited.

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL

The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact any of the staff listed on the Acquisition Research Program website (www.acquisitionresearch.net).

Panel 22. Improving Project Management of Complex Systems

Thursday, May 5, 2016	
3:30 p.m. – 5:00 p.m.	**Chair: William Taylor, Col, USMC (Ret.),** Program Executive Officer Land Systems, Marine Corps ***A Conceptual Framework for Adaptive Project Management in the Department of Defense*** Martin Brown, Jr., Project Manager, Program Executive Office for Enterprise Information Systems ***Program Affordability Tradeoffs*** Brian Schmidt, Economic Analyst, The MITRE Corporation Josie Sterling, Economic/Business Analyst, The MITRE Corporation Patricia Salamone, Business and Investment Analyst, The MITRE Corporation Ginny Wydler, Principal Analyst, The MITRE Corporation ***Squaring the Project Management Circle: Updating the Cost, Schedule, and Performance Methodology*** Charles Pickar, Senior Lecturer, NPS

Squaring the Project Management Circle: Updating the Cost, Schedule, and Performance Methodology

Charles K. Pickar—is a member of the Graduate School of Business & Public Policy faculty at the Naval Postgraduate School. He is a retired Army Officer with extensive experience in defense project management, systems engineering, international security affairs, and strategic planning. He holds a bachelor's degree from the University of Maryland, a master's from The Johns Hopkins University in systems engineering, as well as a master's in national security affairs from the Naval Postgraduate School and a doctorate from Nova Southeastern University. He is fluent in German and Italian. His professional experience includes executive management positions at Lockheed Martin and SAIC. His research interests focus on systems thinking and engineering approaches to management problems. [ckpickar@nps.edu]

Abstract

In the ever increasing complexity of defense acquisition, the traditional metrics for defense projects of cost, schedule, and performance are insufficient. This paper explores the concept of cost, schedule, and performance to determine if these three quintessential project management criteria are sufficient to serve as the guiding principles for defense project managers. The ever increasing complexity of the weapons system development environment, from the necessity for specialization to the intricacies of new technology, requires a broader view than that offered by cost, schedule, and performance. In squaring the project management circle, we must add a fourth variable, context, to provide focus. Because if we measure it, it will get done.

Introduction

This paper is an examination of the complexity of defense acquisition and its relationship to the measures of cost, schedule, and performance—the project management circle (see Figure 1). Rather than use the more traditional name of project management triangle (or triple constraint, or even the iron triangle), we refer to the concept as the project management circle. The circle recognizes the interrelationships, necessary equilibrium, and the influencing and balancing effects that these three variables provide. This paper seeks to demonstrate that these three variables are missing an important consideration that should be held in equal regard. Recognizing that fourth consideration will allow the circle to be squared.

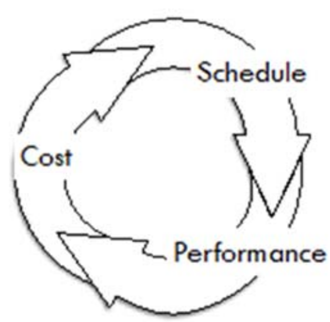


Figure 1. The Project Management Circle

Any discussion of cost, schedule, and performance must include the concept of project success as ultimately, cost, schedule, and performance are meant to ensure success. These three ideas form the heart of the concept of project management and are seen as not only management concepts, but as the definition of success in project management. In fact, cost, schedule, and performance are the prevailing criteria used to evaluate project success in the U.S. Department of Defense, and indeed throughout the U.S. Government. Congress uses cost, schedule, and performance; the media tend to focus on cost, schedule, and performance; and the GAO almost exclusively uses cost, schedule, and performance to measure execution. This paper suggests that the cost, schedule, and performance paradigm, while still effective as a measure of managing programs, needs to be expanded or changed.

The Problem

The current practice of project management assumes a simple, structured, and stable environment where the basic ideas of cost, schedule, and performance are sufficient to capture the workings of weapons system development, as well as serving to define success. However, the DoD environment is complex, dynamic, and constantly changing, and defining success is problematic. In this 21st Century environment, the obligation of management in general and that of project managers specifically is to deal with complexity. Getting the system developed and fielded, regardless of complexity, is the focus of the project management effort.

Simultaneously, while cost and schedule measures remain important, they are insufficient as measures of project success. Nevertheless, the management concepts of cost, schedule, and performance remain the same. We continue to manage and define success in acquisition using cost, schedule, and performance. While important measures, cost schedule, and performance are insufficient criteria for both program management and program success. This is the dilemma facing project managers today.

The Approach

The research seeks to examine the complexity of defense project management and relate that complexity to the key variables of cost, schedule, and performance. The intent is to explore other variables that will better help to explain DoD project success (or failure) and provide the DoD weapons system project manager the ability to manage more effectively. This research attempts to “square” the project management circle by identifying a fourth critical variable that must be addressed by project managers. The research methodology consists of a system-focused approach based on an extensive review of the literature of cost, schedule, and performance, and project complexity.

The analysis consists of three parts. The first section will examine the concept of cost, schedule, and performance. The second section explores DoD project management complexity. Project success is also examined as it relates to complexity and defense acquisition.

Lastly, a fourth variable, the concept of project management context, is introduced. We explore the idea of project context, identifying and categorizing the context of the defense project using a systems framework. The results of the analysis will identify those context variables that would contribute to a project management model addressing complex weapons systems development. The expected result is the identification of variables, beyond cost, schedule, and performance, that contribute to project success and enable the complex systems project manager to better address the management challenges evident in most DoD systems development.

Cost, Schedule & Performance

Cost, schedule, and a third measure—performance, scope, or quality, among others—are as old as the practice of project management. Project managers apply management principles and knowledge to effect change. The Project Management Institute (PMI; n.d.) defines a project as “a temporary endeavor undertaken to create a unique product, service or result.” The temporary aspect emphasizes the limits of project management, the application of finite resources—both time (schedule) and budget (cost). The unique property underlines the focus and purpose of the project, as well as the result—performance. No one would dispute the importance of these concepts, but are these criteria sufficient in today’s complex environment? The reality is projects in general, and complex projects in particular (including defense projects), are often completed late, over budget or both (Morris & Hough, 1988).

While well known to the practice of project management, cost, schedule, and performance are elusive concepts in the context of the academic literature. Cost, schedule, and scope in the construction industry are prevalent, but cost, schedule, and performance as used in defense are not. Most research on cost, schedule, and performance generally focuses on the specifics of earned value and the mechanics of managing weapons systems projects (Atkinson, Crawford, & Ward, 2006; Aubry, Hobbs, & Thuillier, 2007; Gardiner & Stewart, 2000).

The business of defense project management is to create a product—a system comprised of advanced technology for the most part, a weapons system (Gaddis, 1959). Defense project managers manage work (or scope), technology, people, interfaces and the overall system to ensure a viable result. Cost, schedule, and performance are metaphors for trade-offs. The project manager must manage many obvious and sometimes not so obvious constraints and trade those constraints against each other (Caccamese & Bragantini, 2012). This decision function is the essence of project management.

Systems take inputs and transform those inputs into outputs. Mastery of project management requires recognition that the project is a system and that the “black box” (transformation) process of systems development sometimes produces unforeseen results (outputs). These unforeseen results include a continuum that ranges from success to failure in both capability and management. Figure 2 is an Integrated Definition for Function Modeling (IDEF0) representation of the system. Inputs are combined with resources to produce outputs. Controls are the constraints of the system; budget and time are most often the primary constraints, with performance both a constraint as well as an output of the system. The mechanisms include the actual work and application of skills to transform the system. Management of the diverse factors that form the process of weapons system development results in functional integration. Systems integration further highlights the systems nature of defense project management.

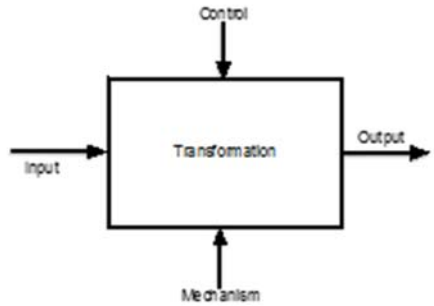


Figure 2. The Systems Nature of Project Management

We manage this system by monitoring, measuring and attempting to control cost, schedule, and performance. However, we often fail to meet these measures. Could it be that DoD projects continue to fail because our management tools consist of this limited set of measurement criteria? After all, the old phrase attributed to past systems thinkers and management experts, “what gets measured gets managed,” is as actual today as when it was first voiced (Willcocks & Lester, 1996). Using the same thinking, a corresponding phrase, “what gets measured gets done,” also rings weak in that we are certainly measuring, but in many cases, project success isn’t getting done.

Further, even if the cost, schedule, and performance criteria are achieved, the only thing demonstrated is that we are meeting goals rather than accurately measuring success (Atkinson, 1999). Are meeting these criteria—cost, schedule, and performance—critical for success, without which the weapons system development is classified as a failure? Senior DoD officials routinely point out that notwithstanding cost and schedule overruns, the weapons systems the DoD produces are the best in the world.

Cost, schedule, and performance were sufficient for the management of simple programs and, in some cases, complicated programs. Complicated programs, while sometimes large and consisting of many moving parts, operate in predictable ways (Sargut & McGrath, 2011). The operation of a weapons system, while complicated (and difficult), is predictable. Complex programs are different. While complex systems may operate in predictable ways, the interactions of elements of the complex system are unpredictable, as they constantly change (Sargut & McGrath, 2011). By their very nature, cost, schedule, and performance are metrics, and as metrics, become predictors. However, it is almost impossible to predict with accuracy the end state of cost, schedule, and performance in complex systems.

Complexity

Complexity is the major dynamic of weapons system development in the 21st Century. Complexity is ever-present, but at the same time constantly changing. The continued growth of complexity has changed the process and the organizations of project management in important ways. Managerial and technical complexity, and the resultant recognition of the limits of human capability, has resulted in necessary changes in both human and organizational capacity. From the human perspective, complexity has spawned specialists—experts in a particular field—able to address those smaller aspects of a complex system that can be handled by a single person. The need to deal with technical complexity while ensuring system capability is the basis for the field of systems engineering, among other technical specializations.

Specialization has a limiting function, in that the specialists in a project organization are measured by, and capable of addressing, only those issues in their specific area. As a result, the project management offices have increased in size to meet the needs of specialization. This has resulted in a corresponding decrease in the visibility over the entire project, a “can’t see the forest for the trees” analogy from the individuals’ perspective. This has the potential of causing a potential decrease in efficiency in the execution of the project.

Complexity in project management refers to those organizational, informational and technical characteristics of the project and, by extension, the project management organization and the technical staff (Baccarini, 1996). Included in the organizational construct are the categories of stakeholders and other interested parties. Complexity has a direct effect on management and decisions as the more complex the system, the potentially more complex the management effort and decisions required. The mixture of human-socio-political complexity found in weapons systems development offices further adds to this complexity (Atkinson, 1999; Pinto, 2000). Finally, complexity reduces the predictability of the outcome of decisions made (Sargut & McGrath, 2011).

Definitions and explanations of complexity, managerial, engineering and technological abound, from Williams to Gell-Mann, to Holland, to Hughes (Gell-Mann, 1995; Holland, 1993; Hughes, 1998; Sargut & McGrath, 2011; Williams, 2002). From the project management perspective, Baccarini (1996) identifies two elements of complexity, organizational and technological complexity. He further subdivides these functions into differentiation and interdependency. Differentiation refers to the varied size and structure of projects and the organizations that manage them, while interdependency describes the activities between these varied elements (Baccarini, 1996).

Williams builds on the Baccarini topology and defines project complexity as categories in two key areas, structural complexity and uncertainty (Williams, 2005). Structural complexity is a result of the number of elements of a project, the pieces, including the people, the organizations, and the technology, coupled with the way these pieces interact, their interdependencies. This combination of interactions of the varied elements is structural complexity (Williams, 2002). Williams’ (2002) second aspect of complexity is uncertainty of the goals and the methods necessary to reach those goals.

Table 1. Project Management Complexity
(Baccarini, 1996; Sargut & McGrath, 2011; Sheard & Mostashari, 2009; Williams, 2002)

Type	Sub-type	Acquisition Management Example
Structural	Size	Organization (number of people) Budget Scope of work Contractor (size and number of people)
	Connectivity/ Actions/ Approvals	Acquisition organizations Requirements organizations Industry organization Review processes (both programmatic and technical)
	Organizational	Stakeholder Organizations Boundaries/ different commands/ different agencies Executive Branch Congress
Uncertainty	Budget	Funding
	Technical Complexity	Variety of tasks Interdependencies between tasks
	Objectives	System Requirements
Dynamic	Short-term	Daily problems Personnel changeover Engineer shortage Materials failures Short requirement dynamics Rework
	Long-Term	Changing budget Environment
Socio-Political	Social-Political	Personnel changeover “the new PEO/ PM” Change and change management Regulations/ Policy changes
System	Interdependency	Emergence Unanticipated actions and consequences a result of incomplete appreciation of system

Sargut and McGrath (2011) identify three properties, multiplicity, interdependence and diversity, as key. Multiplicity refers to the number of interacting elements or scale. This is similar to the Williams construct of structural complexity. Interdependence is the connectivity of different elements. And diversity is a measure of the difference in the elements (Sargut & McGrath, 2011).

From the systems side, Sheard and Mostashari (2009) explain project complexity from the systems engineering perspective. That view acknowledges structural complexity, but adds dynamic and socio-political complexity as factors influencing complex systems development. Dynamic complexity recognizes the active nature, the change-over-time, of systems development. Socio-political complexity reflects the human side of complexity, focusing on the importance and challenges of social interaction in systems development, including the cognitive challenge complexity causes, as well as the effect of everyday politics.

To allow for a more complete analysis, the complexity frameworks developed by Williams based on project management, by Sheard and Mostashari based on systems engineering, and discussed by Sargut and McGrath based on business considerations are combined to illustrate project management complexity in the Department of Defense (Baccarini, 1996; Williams, 2002; Sargut & McGrath, 2011; Sheard & Mostashari, 2009). While the Sheard and Mostashari (2009) framework is focused on systems engineering, it is valuable because it provides an important link from engineering to project management. The resulting framework (Table 1) includes a topology of different kinds of structural complexity, uncertainty, dynamic and socio-political complexity, and overall system complexity.

This grouping of complexity factors combines the management and engineering considerations in the development of weapons systems. In many cases, the resultant complexity is manifested in more than one type. For example, personnel issues including leadership changes have complexity effects in uncertainty, dynamic complexity, and socio-political complexity.

Structural complexity includes the scale, connectivity, organizational structure, and objectives of the development. Size is about magnitude of the acquisition system and its policies, bureaucracy and hierarchy to include the private sector side of defense acquisition. Connectivity acknowledges that the volume of staff actions between these organizations is significant and includes both issues relating to managing ongoing development. The connectivity aspect of structural complexity is influenced by the nature of defense acquisition systems. Since the technology development infrastructure (i.e., laboratories, R&D centers, and manufacturing) is for the most part privately owned, structural complexity also describes the network connectivity necessary for the system to function. Beyond the hierarchies, project organizations are major business entities directly controlling budgeting, spending and, in most cases, the award of fee to defense companies. Project organizations are spread throughout the United States and overseas, further adding to the complexity. Finally, the focus on defense project management by the DoD essentially means project organizations extend from the task level of the project to the highest levels of the bureaucracy. A recent GAO study recognized the challenges of structural complexity in finding the reviews for some programs include up to 56 organizations at eight levels. These structural requirements, reviews and responding to information requests can add up to two years to the development time (GAO, 2015).

Uncertainty focuses on three major areas: budget, technical complexity, and overall system objectives. In defense acquisition, budget is a major concern and source of uncertainty because of the year-to-year budget cycle, as well as political considerations. Uncertainty also stems from the military rotation policy, where senior leaders change jobs approximately every two to three years. Most new leaders are driven to make a mark on the organization and may be therefore unwittingly contributing to the uncertainty of the staff. Technical complexity is a fact of life in defense systems, and the reality is while we plan for technological development, it is in fact an estimate only. As we develop systems, we learn more about the technologies, and are then better able to plan for schedule, and cost.

Dynamic complexity is classified as short and long term and generally refers to change and time available. This concept is divided into the short and the long term because of the differences in perspective, as well as the universe of potential reactions to dynamic complexity (Sheard & Mostashari, 2009). Whether it is a tactical response to a development problem or an administrative response to directives, the project management system is in constant flux. This dynamic is a function of the diverse and always changing aspects of ongoing development. Further, each individual (the human element) will interpret and emphasize different aspects of the problem and how to address that problem. This has a potentially significant impact on the management system.

Socio-political complexity is the nexus between management, and the non-engineering human factors of policy, process and practice of the system is most critical (Maier, 1995). Socio-political complexity also recognizes the politics of project management, starting with the budget process, through Congress, and back into the development organizations. An oft overlooked, but critical aspect of context is politics. In fact, politics is by far the most powerful factor in the category of context. Most engineers and project managers dismiss politics as the realm of higher-level decision makers. In fact, many refuse to engage in politics as they find the practice distasteful (Pinto, 2000). However, dismissing those political activities can have consequences. Whenever people are put in an organization and asked to function as a team, there is an inevitable use of power and political behavior (Pinto, 2000). Notwithstanding a general distaste for political behavior in the workplace, the reality is the practice of politics is a prime force in any weapons development.

The last aspect of complexity in the context of program management is overall system complexity. System complexity is the result of the interaction of all the stated elements of project complexity. When different systems interact, or when different aspects of complexity act on each other, there are two results. The first is the cumulative effect of the interaction. For the project organization, the interdependencies between those managing the development and those executing the development should result in repeatable, consistent results—continued progress in system development (Rebovich, 2008). However, when the link between those managing and those executing is broken or, as can happen, ignored, the interdependency is broken.

In today's environment, the concentration of the defense project manager role on the program (work/scope), the technology to be developed, the interfaces of the system including those non-technical interfaces, and the project environment—the ecosystem of the development. Thus, complexity requires a different approach to project management, one that acknowledges the importance of managing resources (cost and schedule) to optimize system performance, but at the same recognizes the crucial known and unknown constraints and interdependencies of the environment—the context of the system development.

Project Success

Cost, schedule, and performance are both a management tool as well as a predictor of success. The management science discipline has sought to quantify the activities of the various management disciplines, including project management. Tishler et al. (1996) observed that in order to identify the managerial factors (and by extension the processes leading to those factors), success must be defined. They further cite research by Pinto and Slevin (1998) that definitions of success change during different phases of the lifecycle.

A major focus of the literature on project success has been on the idea of success criteria, or critical success factors (CSF; Jugdev & Müller, 2005). Identified success factors include cost, schedule, and performance, as well as project functionality and its management (Morris & Hough, 1988). Further studies added criteria such as customer satisfaction, efficiency of execution, and effectiveness of the project organization (Pinto & Slevin, 1998). Tishler et al. (1996) suggest groupings of four critical success factors for defense oriented projects, preparation, quality of the system development team and the user customer organization, management policy and project control. This clustering of success factors represents the amalgamation of the broader literature on project success criteria (Atkinson, 1999; Cooke-Davies, 2002; De Wit, 1988; Morris & Hough, 1988; Pinto & Mantel, 1990; Pinto & Slevin, 1998).

Preparation for project execution includes the necessary planning for initiating the project, as well as the necessary coordination. Included in the idea of preparation is an assessment of the urgency of need as urgency in defense projects overcomes many constraints. Team quality refers to both the management as well as technical capabilities of the development organization. Management policy is focused on quality, producibility, and design-to-cost considerations. Project control relates to the systematic use of control methods for cost, schedule, and performance. Together, these factors represent the criteria generally necessary for projects to be successful. This suggests that the exclusive and rigid adherence to cost, schedule, and performance as indicators of success (and the hallmark of defense project management) alone does not reflect the totality of success in defense project management.

Most importantly, the literature identifies two kinds of success, project success and project management success (Cooke-Davies, 2002; De Wit, 1988; Jugdev & Müller, 2005). Project success is measured as achieving technical performance and/or mission performance goals, coupled with customer (warfighter) satisfaction (De Wit, 1988). Project success is measured against the overall objectives of the development (Cooke-Davies, 2002). The nature of defense acquisition requires weapons systems that function as intended. This is measured in very real terms of life or death and battlefield success or failure. Rigid adherence to and sole focus on cost, schedule, and performance mean little if the system does not perform when needed (Cleland & King, 1983). In the greater scheme of things, what matters in defense acquisition is whether the system functions as the warfighter needs.

A major, complex project's principal success criteria will vary over time (Atkinson, 1999; De Wit, 1988; Morris & Hough, 1988). To paraphrase de Wit (1988), defense projects have at least three specific indicators of success: identifying the technology, developing the technology, and developing the weapons system using the technology. Delivering capable weapons systems is project success. But, identifying the technology and developing the technology are also measures of project success.

Cost, schedule, and performance measure project management success. At its heart, project management success is a measure of how efficiently the project has been managed (Baccarini, 1999). Project success is different from project management success. Project success will be determined by the warfighter community.

Project management success includes overcoming issues such as supply-chain challenges and effective coordination within the project management office. Project management success is focused on the development process. The DoD, the GAO, and Congress measure project management success, rather than project success. Project management success, however, is and must remain subordinate to project success. Cost, schedule, and performance are inadequate indicators even for project management success.

Context, the Fourth Criterion

The factors of complexity identified in Table 1 provide a starting point for identification of factors that are beyond the basics of cost, schedule, and performance, yet influence project and project management success. From a systems perspective, execution of weapons system development must be considered from the viewpoint of all stakeholders (Owens et al., 2011). This viewpoint includes an appreciation of the identified elements of complexity, including structure, uncertainty, dynamics, socio-political and system. These factors of complexity constantly shape the project environment and form the basis of the context of the system within which the project manager must operate. We group these complexity factors that are the result of the execution of a project together and define them as context (Owens et al., 2011).

Context includes those project organization activities that are essential to administer programs, but are not directly related to the cost, schedule, and performance of the project. Context ranges from tracking budget requests through the bureaucracy to responding to stakeholder inquiries on how resources are being used. In weapons system development, context includes those activities that, while not tied directly to cost, schedule, and performance, are essential for execution.

Each project is unique, a mix of many factors. More than cost, schedule, and performance, context reflects the ecosystem of the project organization and the project. If cost, schedule, and performance are measures and criteria for project management success, context is a criterion for project success.

The goal of this paper was to explore the concept of cost, schedule, and performance to determine if these three quintessential project management criteria were sufficient to serve as the guiding principles for defense project managers. The ever increasing complexity of the weapons system development environment, from the necessity for specialization to the intricacies of new technology, requires a broader view than that offered by cost, schedule, and performance. In squaring the project management circle, we must add as fourth variable, context, to provide focus because if we measure it, it will get done.

References

Atkinson, R. (1999). Project management: Cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management, 17*(6), 337–342. http://doi.org/10.1016/s0263-7863(98)00069-6

Atkinson, R., Crawford, L., & Ward, S. (2006). Fundamental uncertainties in projects and the scope of project management*. International Journal of Project Management, 24*(8), 687–698. http://doi.org/10.1016/j.ijproman.2006.09.011

Aubry, M., Hobbs, B., & Thuillier, D. (2007). A new framework for understanding organisational project management through the PMO. *International Journal of Project Management, 25*(4), 328–336. http://doi.org/10.1016/j.ijproman.2007.01.004

Baccarini, D. (1996). The concept of project complexity–A review. *International Journal of Project Management, 14*(4), 201–204.

Baccarini, D. (1999). The logical framework method for defining project success. *Project Management Journal.*

Caccamese, A., & Bragantini, D. (2012). *Beyond the iron triangle: Year zero*. Project Management Institute.

Cleland, D. I., & King, W. R. (1983). *Project management handbook*. New York, NY: Van Nostrand Reinhold.

Cooke-Davies, T. (2002). The "real" success factors on projects. *International Journal of Project Management, 20*(3), 185–190.

De Wit, A. (1988). Measurement of project success. *International Journal of Project Management, 6*(3), 164–170. http://doi.org/10.1016/0263-7863(88)90043-9

Gaddis, P. O. (1959, May–June). The project manager. *Harvard Business Review*.

GAO. (2015). *Acquisition reform: DOD should streamline its decision-making process for weapon systems to reduce inefficiencies* (GAO-15-192). Washington, DC: Author.

Gardiner, P. D., & Stewart, K. (2000). Revisiting the golden triangle of cost, time and quality: The role of NPV in project control, success and failure. *International Journal of Project Management, 18*(4), 251–256. http://doi.org/10.1016/s0263-7863(99)00022-8

Gell-Mann, M. (1995). What is complexity. *Complexity, 1*(1), 16–19.

Holland, J. H. (1993). Complex adaptive systems. *A new era in computation*.

Hughes, T. P. (1998). *Rescuing Prometheus*. New York, NY: Pantheon.

Jugdev, K., & Müller, R. (2005). A retrospective look at our evolving understanding of project success.

Maier, M. (1995). Social systems engineering and architecture. In *Proceedings of the Fifth International Symposium of the National Council on System Engineering* (Vol. 1, pp. 139–146).

Morris, P., & Hough, G. H. (1988). *The anatomy of major projects*. John Wiley & Sons.

Owens, J., Ahn, J., Shane, J. S., Strong, K. C., & Gransberg, D. D. (2011). Defining complex project management of large U.S. transportation projects: A comparative case study analysis. *Public Works Management & Policy, 17*(2), 170–188. http://doi.org/10.1177/1087724x11419306

Pinto, J. K. (2000). Understanding the role of politics in successful project management. *International Journal of Project Management, 18*(2), 85–91. http://doi.org/10.1016/s0263-7863(98)00073-8

Pinto, J. K., & Mantel, S. J. J. (1990). The causes of project failure. *IEEE Transactions on Engineering Management, 37*(4), 269–276. http://doi.org/10.1109/17.62322

Pinto, J. K., & Slevin, J. K. (1998). Project success: Definitions and measurement techniques. *Project Management Journal*, 1–7.

Rebovich, G. (2008). *The evolution of systems engineering* (pp. 1–5). Paper presented at the 2008 Annual IEEE Systems Conference. http://doi.org/10.1109/SYSTEMS.2008.4518992

Sargut, G., & McGrath, R. G. (2011). Learning to live with complexity. *Harvard Business Review, 89*(9), 68–76, 136.

Sheard, S. A., & Mostashari, A. (2009). A complexity typology for systems engineering. *Systems Engineering*.

Tishler, A., Dvir, D., Shenhar, A., & Lipovetsky, S. (1996). Identifying critical success factors in defense development projects: A multivariate analysis. *Technological Forecasting and Social Change, 51*(2), 151–171. http://doi.org/10.1016/0040-1625(95)00197-2

Willcocks, L., & Lester, S. (1996). Beyond the IT productivity paradox. *European Management Journal, 14*(3), 279–290. http://doi.org/10.1016/0263-2373(96)00007-2

Williams, T. (2002). *Modelling complex projects*. New York, NY: John Wiley & Sons.

Williams, T. (2005). Assessing and moving on from the dominant project management discourse in the light of project overruns. *IEEE Transactions on Engineering Management, 52*(4), 497–508. http://doi.org/10.1109/TEM.2005.856572

Project Management Institute (PMI) . (n.d.). What is project management? Retrieved from http://www.pmi.org/About-Us/About-Us-What-is-Project-Management.aspx

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL
555 DYER ROAD, INGERSOLL HALL
MONTEREY, CA 93943

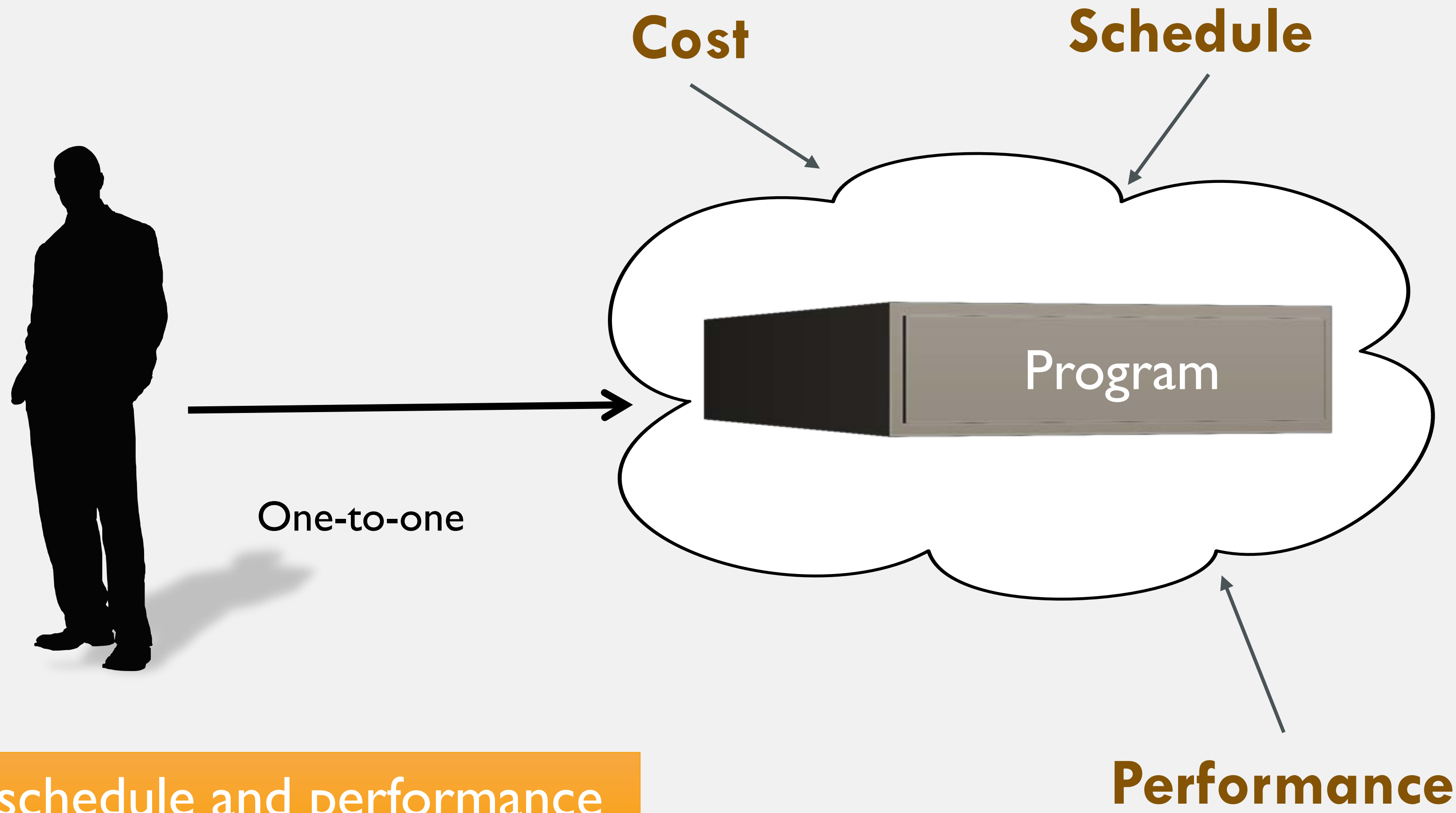
www.acquisitionresearch.net

SQUARING THE PROJECT MANAGEMENT CIRCLE:

UPDATING THE COST, SCHEDULE, AND PERFORMANCE METHODOLOGY

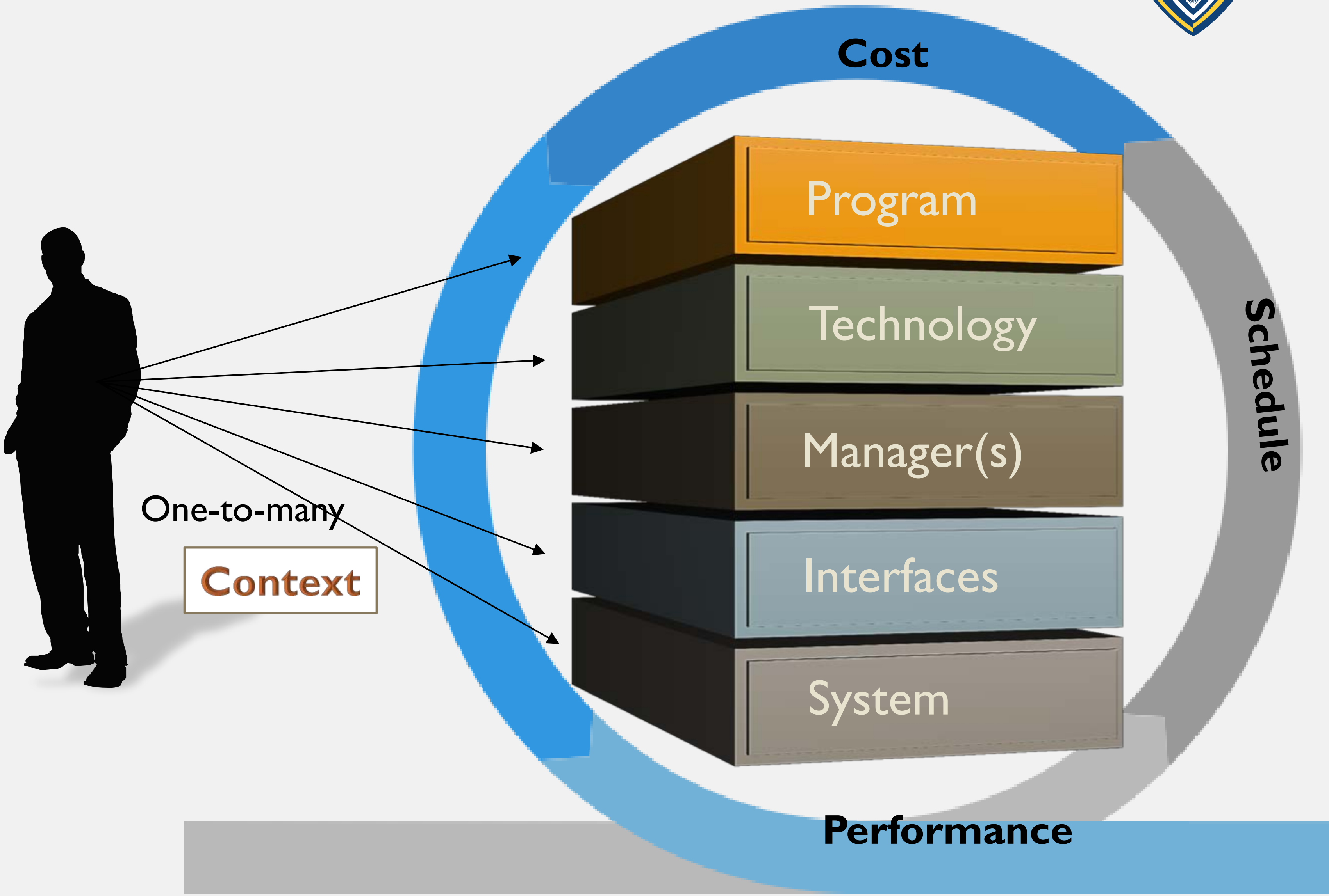
Charles K. Pickar, Naval Postgraduate School

MANAGING SYSTEMS PROJECTS (CURRENT APPROACH)



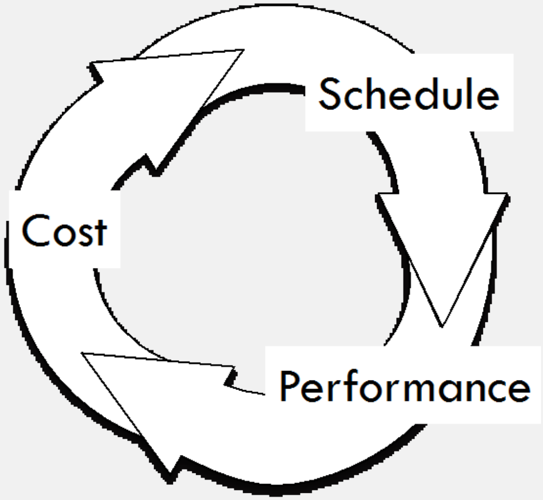
Cost, schedule and performance is the Management Mantra

MANAGING SYSTEMS PROJECTS (DEFENSE ENVIRONMENT)



OVERVIEW

- Problems
- The Project Management Circle
  - Cost, Schedule Performance
  - Project Success
- Methodology—Systems Approach
  - Cost, schedule and performance
  - Defense Project Complexity
- Conclusion



Goal: Identify Factors beyond Cost, Schedule & Performance that influence defense development programs

Ultimate use is to model the defense acquisition process
to provide a training environment for PMs

PROBLEM 1—DEFENSE SYSTEMS DEVELOPMENT ENVIRONMENT

- Defense systems acquisition has three major characteristics…
  - Complex (well beyond complicated)
  - Not transparent (opaque)
  - External and internal dynamics that are not completely understood by the people charged with their execution.

→ Results in imperfect decision making

- DoD Focus driven by cost, schedule and performance considerations
  - overly simplistic short-term decisions made without considering their later effects…. Providing a less than optimal decision focus

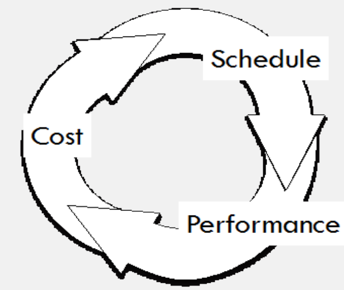
THINGS ~~PROJECT MANAGERS~~ *PEOPLE* DON'T DO WELL

- Take the long-view…anticipating the consequences of decisions
- Anticipate future problems
- Appreciate the effects of Time (delayed feedback systems)
- Easily understand large amounts of data
- Change—we tend to hold on to beliefs **more** strongly when we feel insecure/challenged/ are wrong.
- Deal with Complexity

PROBLEM 2—DEFINING SUCCESS

Project Success

...achieving technical performance and/ or mission performance goals, coupled with customer (warfighter) satisfaction

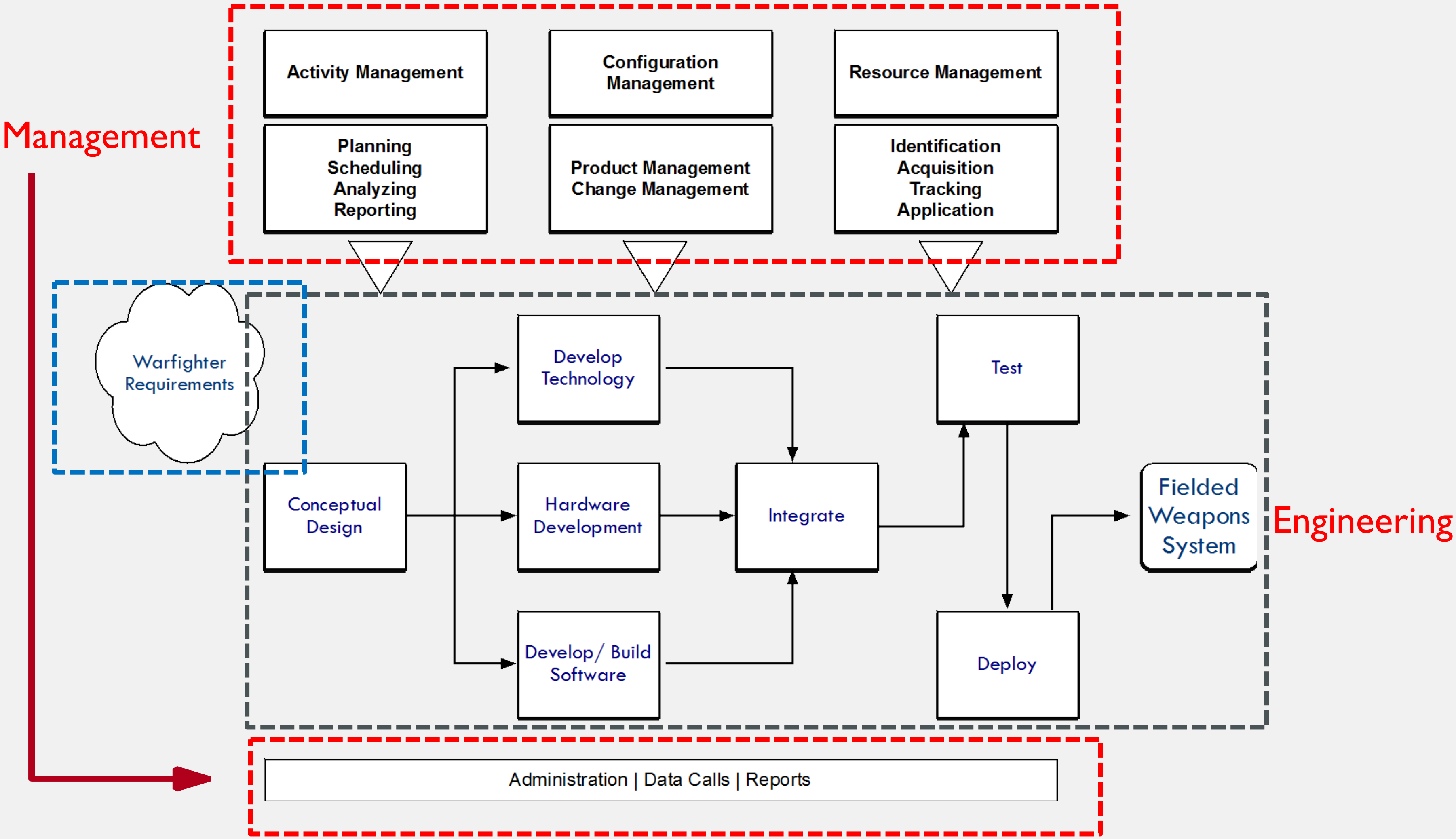


Project Management Success

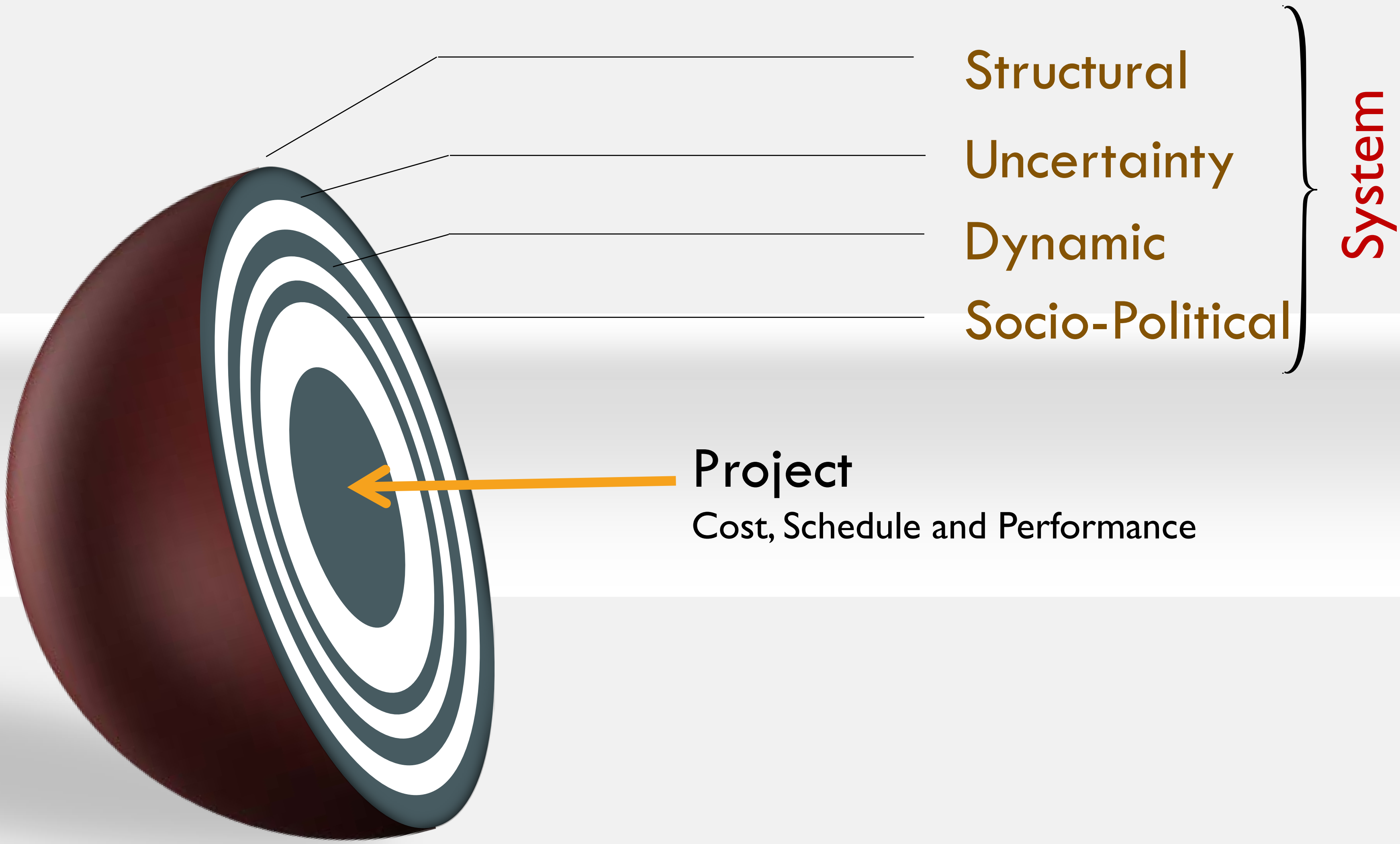
...how efficiently the project has been managed

Imperfect understanding of project success

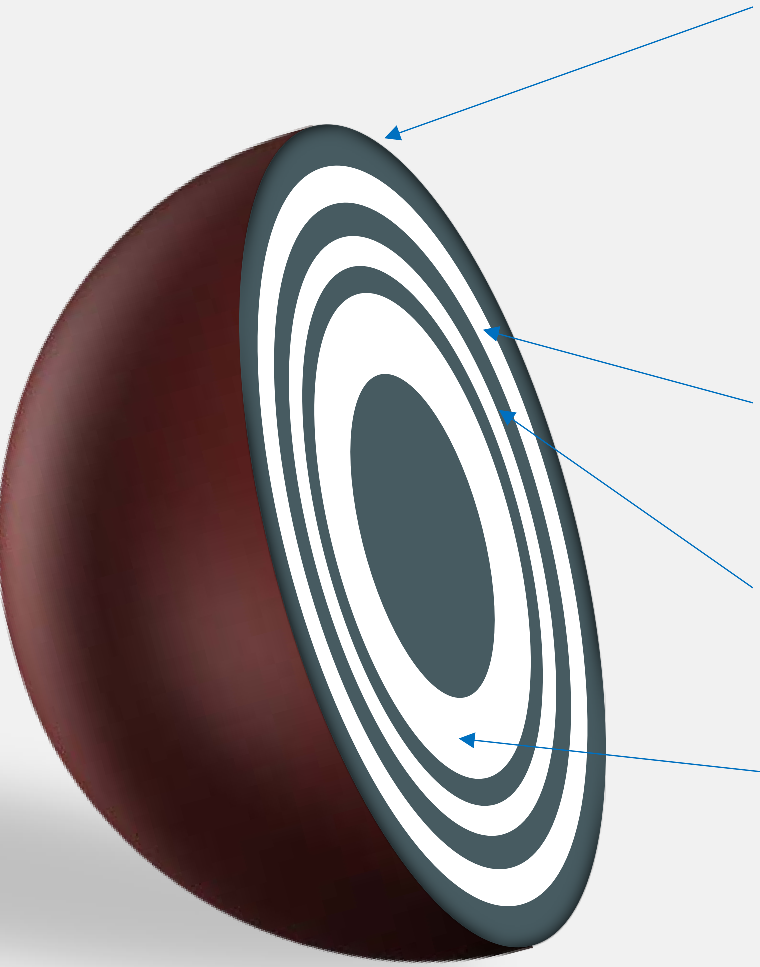
PROJECT MANAGEMENT IS ACCOMPLISHED BY MANAGEMENT & ENGINEERING PROCESSES…DRIVEN BY REQUIREMENTS



COMPLEXITY AS CONTEXT



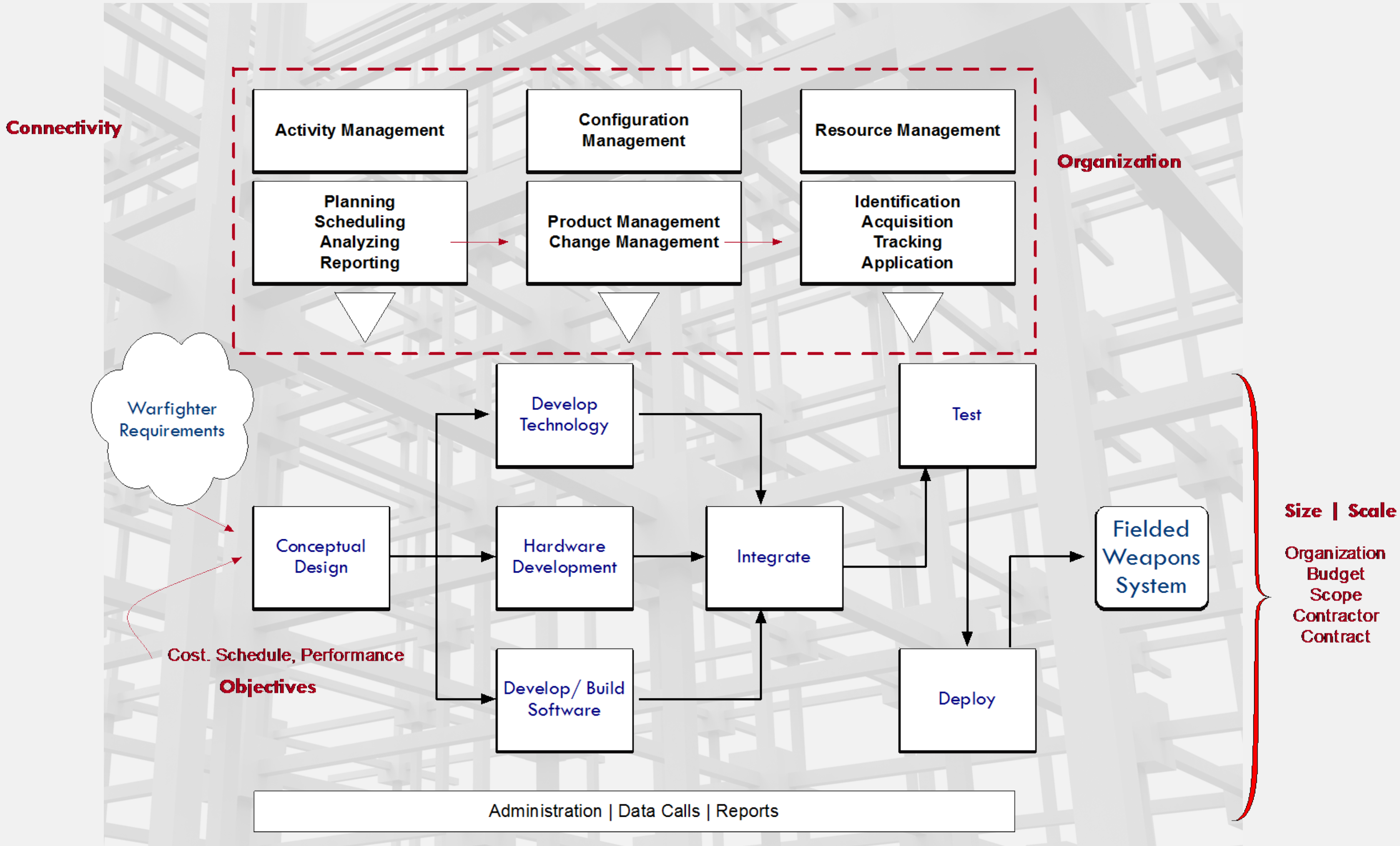
COMPLEXITY* AS CONTEXT



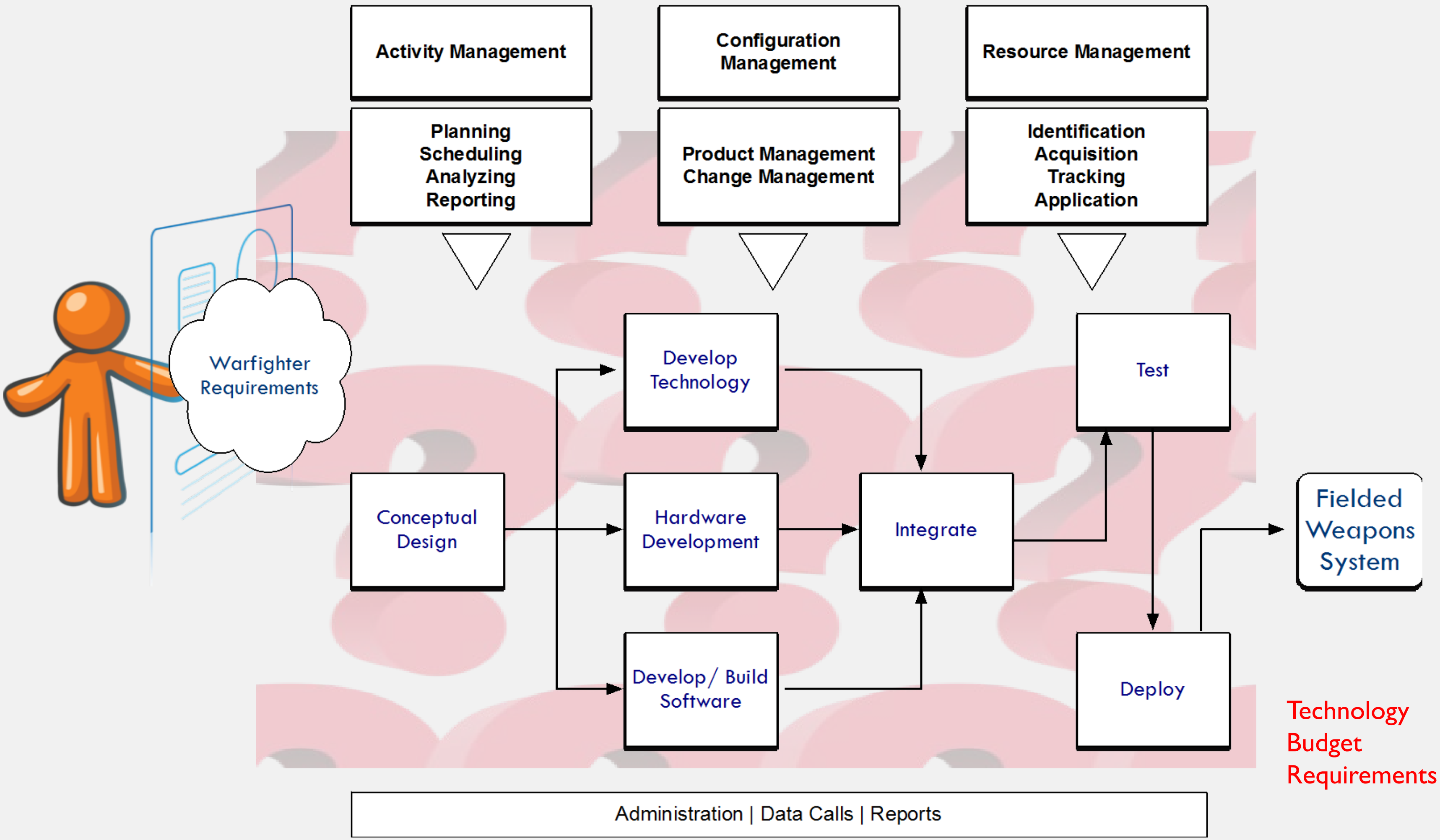
Type	Sub-type	Aquisition Management Example
Structural	Size	Organization (number of people) Budget Scope of work Contractor (size and number of people)
	Connectivity/ Actions/ Approvals	Acquisition organizations Requirements organizations Industry organization Review processes (both programmatic and technical)
	Organizational	Stakeholder Organizations Boundaries/ different commands/ different agencies Executive Branch Congress
Uncertainty	Budget	Funding
	Technical Complexity	Variety of tasks Interdependencies between tasks
	Objectives	System Requirements
Dynamic	Short-term	Daily problems Personnel changeover Engineer shortage Materials failures Short requirement dynamics Rework
	Long-Term	Changing budget Environment
Socio - Political	Social-Political	Personnel changeover "the new PEO/ PM" Change and change management Regulations/ Policy changes
System	Interdependency	Emergence Unanticipated actions and consequences a result of incomplete appreciation of system

*After Sheard and A. Mostashari, "A complexity typology for systems engineering," *Syst. Eng*, 2009.

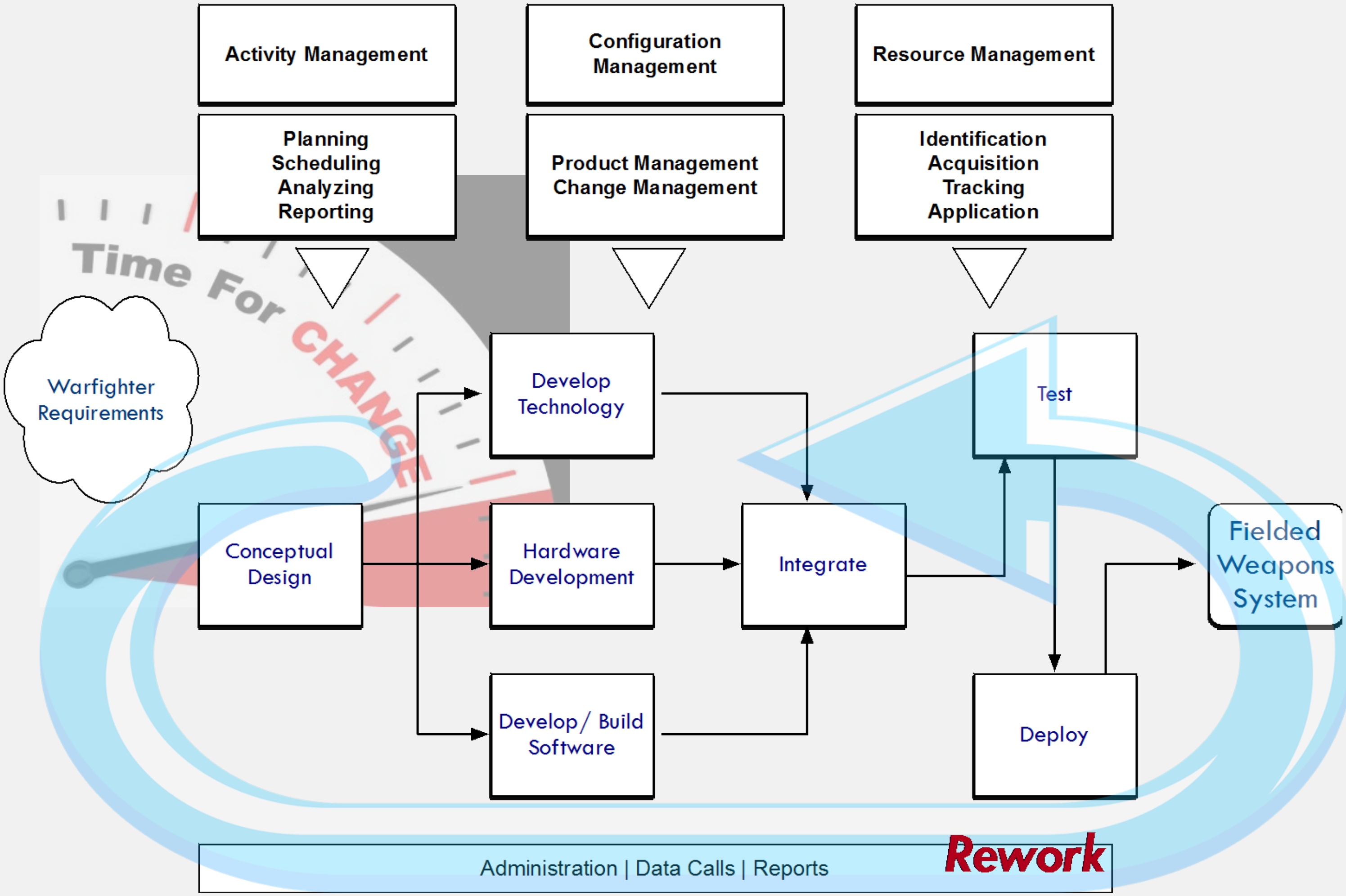
STRUCTURAL COMPLEXITY



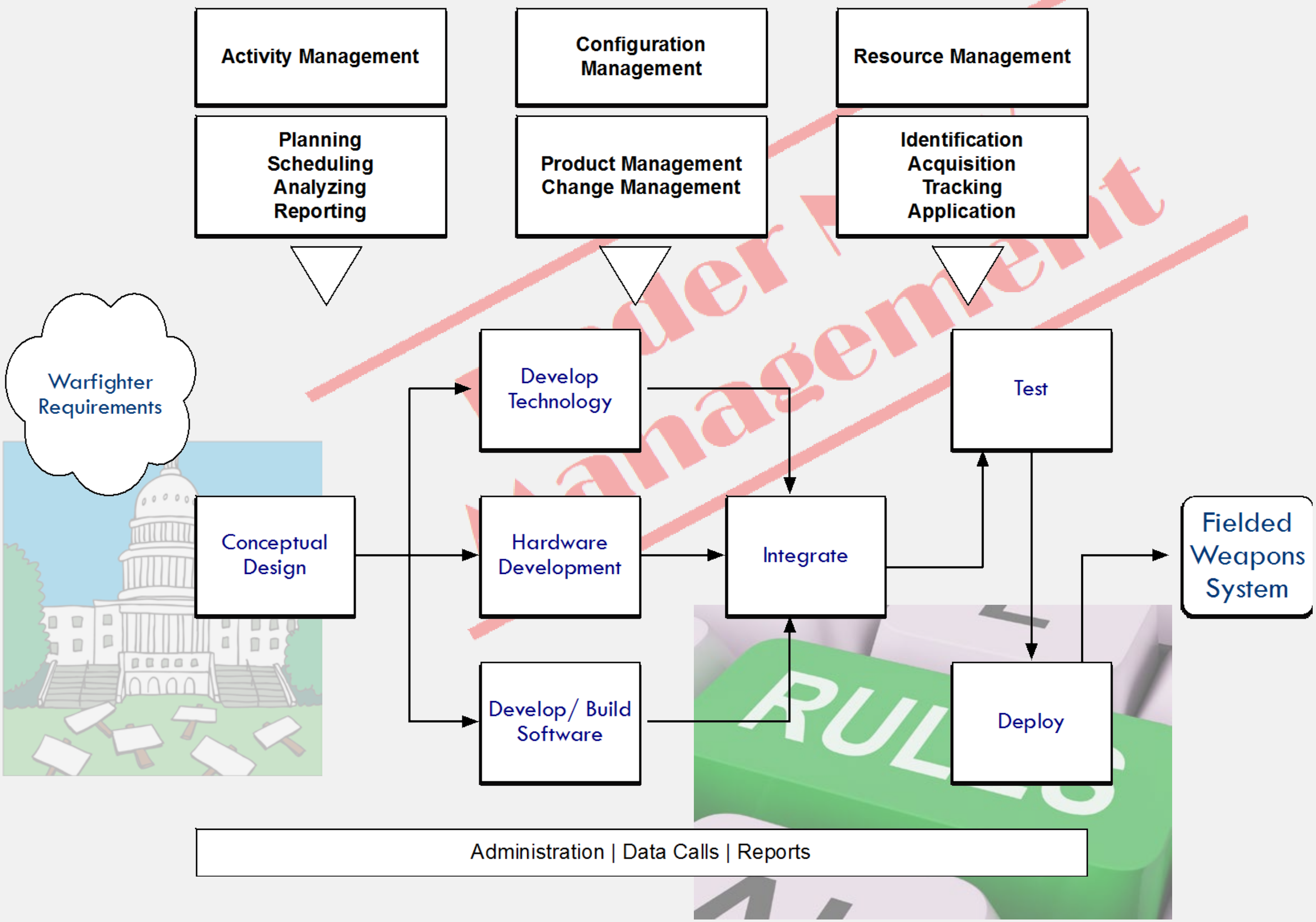
UNCERTAINTY



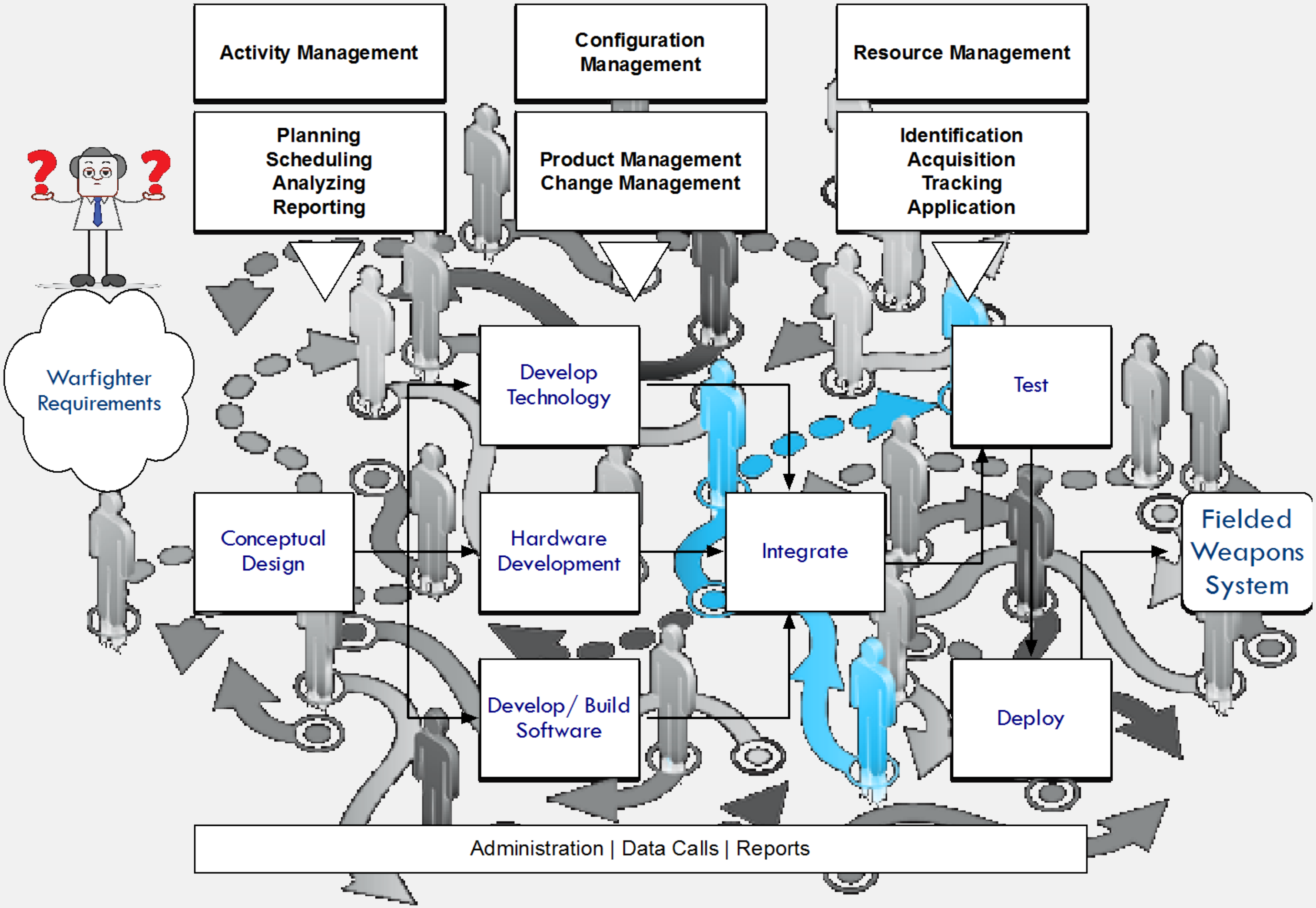
DYNAMIC COMPLEXITY



SOCIO-POLITICAL COMPLEXITY



SYSTEM COMPLEXITY

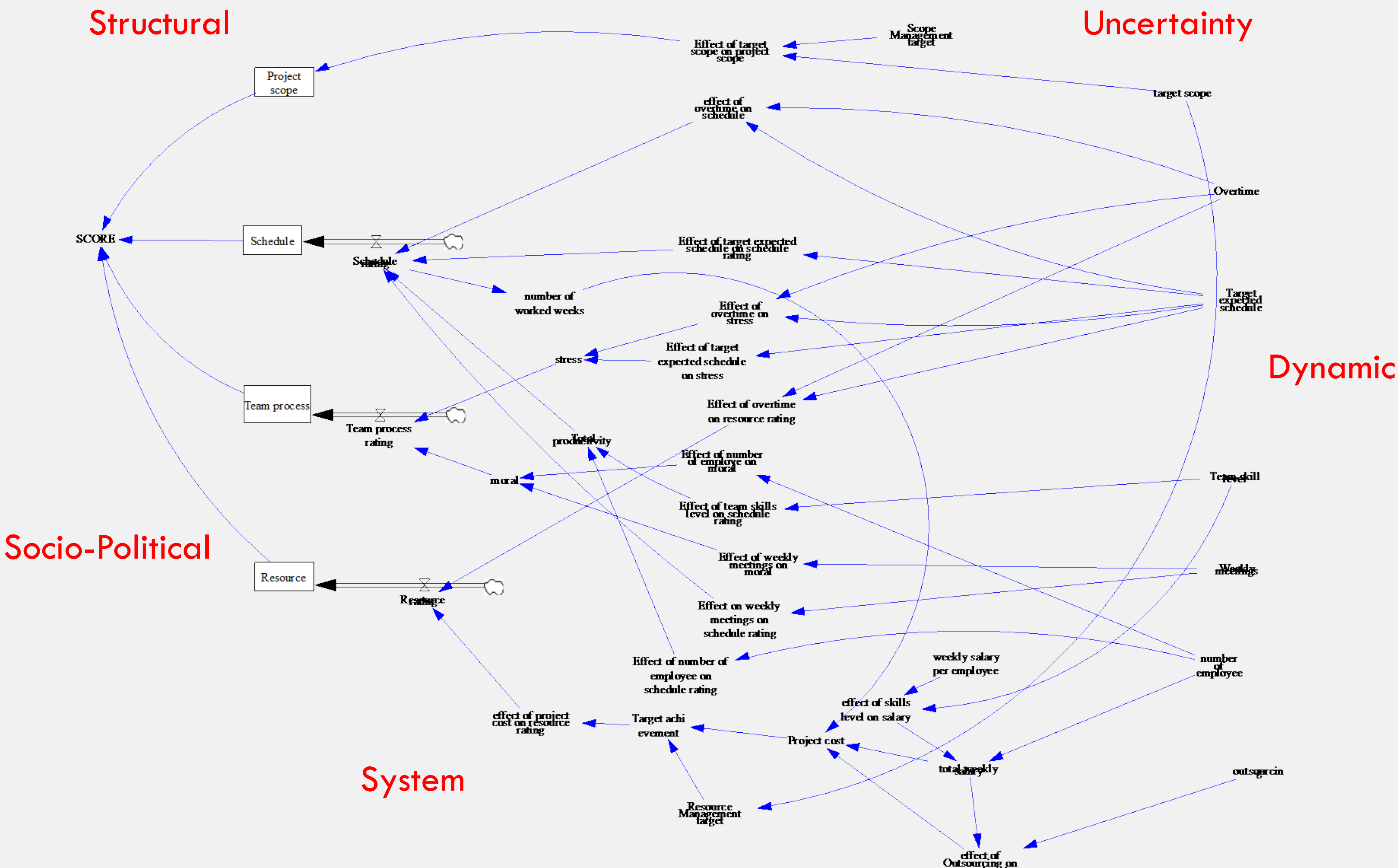


SO WHAT?

GETTING TO PROJECT SUCCESS

Context

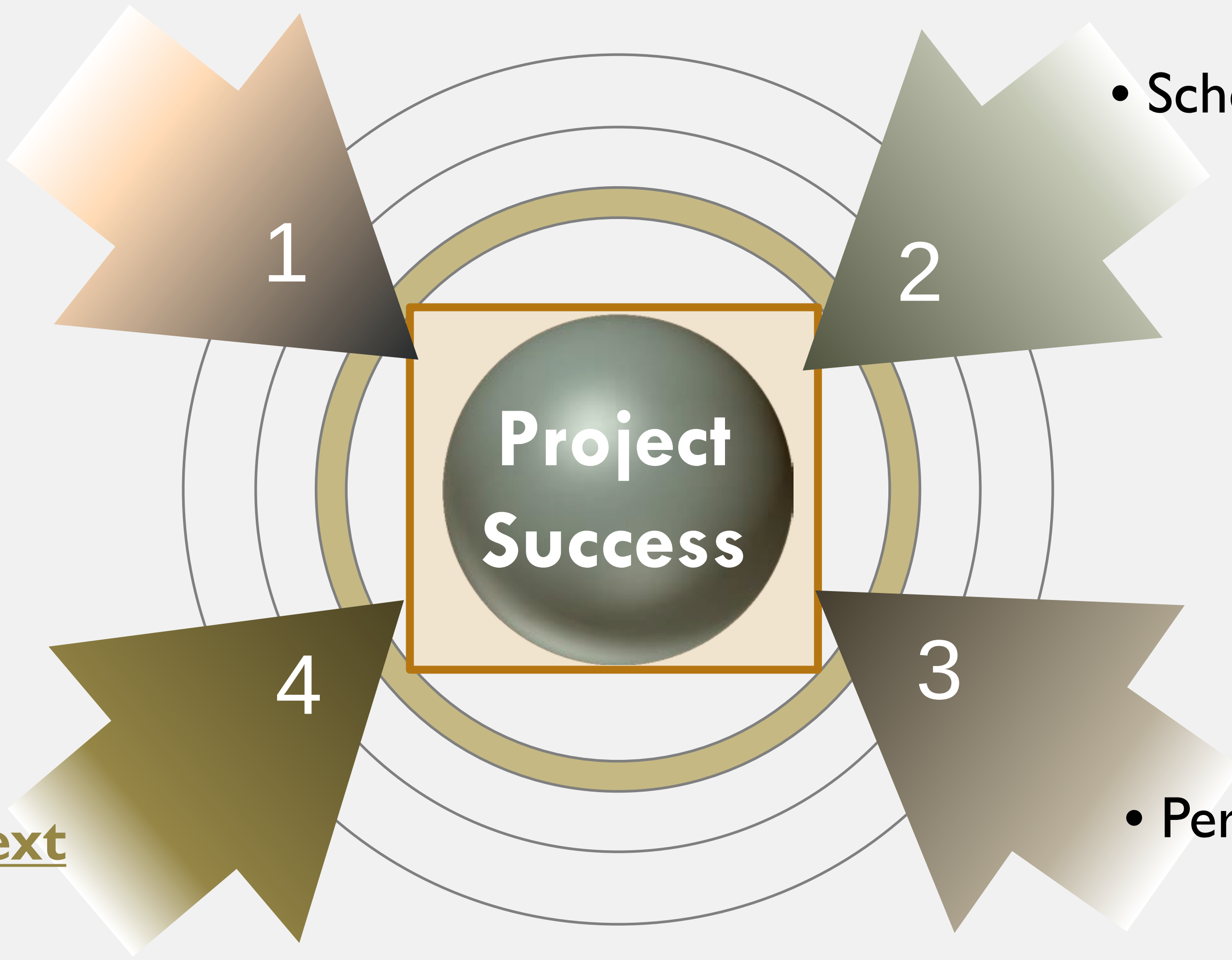
APPLYING CONTEXT VARIABLES



SQUARING THE CIRCLE

- Cost

- Schedule



- Performance

- **Context**

CONCLUSION

- Cost, Schedule and Performance are insufficient to inform today's defense project/ engineering management environment
- Context shapes the project development process—it is at the heart of successful execution
- A thorough appreciation of the effects of context variables is critical for successful program execution

QUESTIONS

CHARACTERISTICS OF PROCESS*

- Define how the work of the organization is done
- Logical organization of people, materials, energy, equipment and procedures into work activities designed to produce a result.
- Set of processes lead to the accomplishment of a task
- Cross organizational boundaries (between tasks and organizations)
- Process Entities
  - Interorganizational
  - Interfunctional
  - Interpersonal
- Process Activities
  - Operational
  - Managerial

A Systems Approach to Project Management Research is Essential

*Davenport, T. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign | MIT Sloan Management Review. MIT Sloan Management Review. Retrieved from http://sloanreview.mit.edu/article/the-new-industrial-engineering-information-technology-and-business-process-redesign/